NATIONAL BUREAU OF STANDARDS REPORT

9694

DEVELOPMENT, TESTING, AND EVALUATION OF VISUAL LANDING AIDS

Consolidated Progress Report

For the Period

October 1 to December 31, 1967

By
Photometry Section
Optics Metrology Branch
Metrology Division
Institute for Basic Standards

U.S. DEPARTMENT OF COMMERCE
NATIONAL BUREAU OF STANDARDS

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[1] Headquarters and Laboratories at Gaithersburg, Maryland, unless otherwise noted; mailing address Washington, D. C., 20234.

[2] Located at Boulder, Colorado, 80302.

[3] Located at 5285 Port Royal Road, Springfield, Virginia 22151.

NATIONAL BUREAU OF STANDARDS REPORT

NBS PROJECT		NBS REPORT
2120411	March 14, 1968	9694
2120414		
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DEVELOPMENT, TESTING AND EVALUATION OF VISUAL LANDING AIDS

Consolidated Progress Report to
Ship Installations Division
and
Meteorological Division
Naval Air Systems Command
Department of the Navy
and to
Federal Aviation Administration

For the Period
October 1 to December 31, 1967

By
Photometry Section
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NATIONAL BUREAU OF STANDARDS

Development, Testing, and Evaluation of Visual Landing Aids

October 1 to December 31, 1967

I. REPORTS ISSUED

Report No.	Title
9661	Development, Testing, and Evaluation of Visual Landing Aids, Consolidated Progress Report for Period July 1 to September 30, 1967
212.11-88/66	Photometric Tests of Fixtures for Use as Heliport Perimeter Lights
212.11-103/66 Supplement	Life Test of "Factory-Aimed" Type PAR-64 Iodine-Cycle VASI Lamps
212.11-22/67 Supplement	Life Test of Type Q6.6A/PAR56/2 Approach-Light Lamps
Memorandum Report	Effects of Length of Feeder Cable on the Effective Intensity of a SATS Condenser-Discharge Approach Light
Letter Report	Effect of Lead Length on the Effective Intensity of Condenser-Discharge Approach Lights

II. VISIBILITY METERS AND THEIR APPLICATION

Shipboard Visibility Meter.

The instrument was installed on the roof of the Administration Building at NBS, Gaithersburg, during the first week of October. The system was placed into operation without problems. Initially the instrument was operated only in the "Day" mode and turned off at night since the background light level was too high for operation in the "Night" mode at 5PM. The high intensity flash of the "Day" mode is a possible annoyance to the neighbors at night and therefore has not been used. The instrument was operated each working day and occasionally at night for the month of October.

The termination of daylight saving time allowed "Night" mode operation before 5PM. Twenty-four hour operation during the work week was started. Extended operation in the "Night" mode indicated that the flash lamp misfired every couple of minutes. Since the peak detector circuits are discharged to zero before each flash, a spike is recorded each time there is a miss. The output signal changes toward the value corresponding to the logarithm of zero or infinity for the time between two flashes. The desired information on the chart was excessively obscured. Several days were spent determining why the lamp misfired only in the low energy mode.

Experimentation indicated that increasing the energy of the discharge (by increasing the storage capacitor or the voltage to which it is charged) increased the time between misfirings. It was learned from the flash lamp manufacturer that the energy in the discharge must be sufficient to keep the cathode surface clean. An operating voltage of at least 2kV was also recommended. In the middle of November, the 100μF and 4μF capacitors operated at 1.6kV were changed to 50μF and 8μF operated at 2kV. The instrument was put back into operation. The frequency of misfiring was reduced to about 4 times per hour. With the FT-34/HP flash lamp used, it has been found that the energy per flash must be at least 15 to 30 joules to keep the frequency of misfiring down to a few per hour. After operating for another month, the identical lamp is now misfiring only once in a few hours.

When the instrument was moved to install the new capacitors, the photomultiplier tube was apparently damaged either by exposure to excessive light or mechanical shock. The tube saturated at light levels used previously. The photomultiplier was replaced and normal operation resumed. After a week of operation the signal commutating relay did not make contact in one position

after the instrument had been on stand-by for a weekend. The relay was replaced. Since that time, the instrument has been operated 24 hours a day except for weekends. No problems have occurred after three weeks. Rain, fog and snow have occurred during this period.

During this quarter the majority of the circuit diagrams have been completed. Operating instructions, circuit description, and maintenance and calibration instructions have been written. The preliminary instruction manual should be completed early in the next quarter.

Fog Detector Field Tests.

The regular fog season ended early this year but there have been brief periods of fog scattered over the last months of this period which were useful for testing the fog detectors. Malfunctions and unsatisfactory operation of the instruments under test limited the data obtained during the fog season. Some of the instruments were received late in the period and others are expected to be delivered next quarter. These will be installed and data obtained when suitable weather conditions occur during the winter and spring.

The Edison Fog Detector.

The Edison forward-scatter fog detector was in operation throughout this period. The increased response in drizzle and rain which was reported last quarter was found to be caused by water droplets forming on the bottom of the external baffle of the unit and refracting light from the source into the receiver. The output of the instrument appears almost as a square wave in some weather conditions with a sharp increase in output as the droplet reaches a critical size. The output then changes very little until the droplet falls. This refracted light signal can seriously affect the performance as a visibility meter or as a fog detector. A redesign of the baffle is required. After the instrument had been operated continuously in the field for about three months, the sensitivity of the receiver had decreased to about one-third of that obtained at the beginning of the field tests. The detecting element in the receiver was replaced and the response increased by a factor of 10 or more. With the new detecting element, the noise level was approximately 10% of the full scale reading and changed only slightly from night to day. In less than two months operation with the new detecting element, the sensitivity is again decreasing considerably and the daylight noise level is more than twice that at night. The base of the lamp in the light source is being eaten away. This is probably caused by the ultraviolet radiation attacking the bakelite.

The Hoffman VMS-508A Fog Detectors.

A second Hoffman backscatter fog detector type VMS-508A was received from the U. S. Coast Guard. This unit was obtained for checking the first unit for calibration and noise level. However, the second unit had an erratic signal output similar to that of the first unit and other abnormal characteristics which made calibration impossible. Since neither unit was performing as intended, both were returned to the manufacturer for repairs. These units are to be returned to Arcata for further testing after the repairs are completed.

The Frungel Side-Scatter Fog Detector.

The Frungel side-scatter fog detector as received would not work because of faulty components in the receiver unit. (This unit was known to be inoperative when it was shipped to Arcata. It was included in the test program as a means of testing the general performance of side-scatter type instruments, not for tests of the specific instrument.) Since this unit was foreign made and no information was available on the imbedded components, attempts to repair this unit were not considered practical. Operation was attempted using a separate operational amplifier and an integrating circuit on the signal from the phototubes. When the unit was tested in the laboratory a useful signal was obtained by using a sheet of white paper to reflect the signal. When it was installed in the field, no useful data was obtained and the light source failed after operating about one month. During this preliminary work it was found that a well regulated voltage source was required to maintain a constant flash rate of the light source. Also separate direct current power sources are required for the light source and the receiver because transients from the light source flash interfere with the detected signal when a common power source was used. Testing of this instrument will be discontinued. Later, in order to test equipment based on the side-scatter principle, the receiver amplifier may be redesigned and new tests made.

The AGA Fog Detector.

A backscatter fog detector type RTM 1 B manufactured by AGA Aktiebolag was received from the Coast Guard for test. The emitter and the receiver are mounted in a single housing. The emitter uses a 12-volt incandescent lamp operated at 5. 6 volts mounted in an optical system. The emitted beam passes through an infrared filter and is then chopped at 750 hertz. A pilot beam comes off one side of the lamp and passes through the filter and the chopper. This beam is 180 degrees out of phase with the main beam. By a system of prisms the pilot beam is directed into the receiver optics. The pilot beam passes through a variable neutral density ("gray-scale") disc between the lamp and the receiver.

This disc is adjusted to obtain the desired level for energizing the fog alarm circuit. The light from the emitter scattered back into the receiver by particles in the air and the light from the pilot beam are both detected by the same receiver optics but are out of phase. The fog alarm circuit is actuated when the flux received from the scattered light is greater than the flux received from the pilot beam, for a period longer than the built-in time delay. The visibility range of this equipment is approximately 0.5 to 3 nautical miles. The instrument does not have means for determining the magnitude of the output signal. Therefore, it will be tested specifically as a fog detector and not as a possible visibility meter. This fog detector was mounted on the platform of the projector stand of the transmissometer used for comparison. A calibration of gray-scale settings to compare with visibility or transmittance was not provided. In the one period of fog occurring during this quarter after this equipment was installed in the field, the gray-scale was adjusted for the balance position for a large number of conditions over a range of visibility conditions from 1/16 to 10 miles--transmittance over a 250-foot baseline from 0.1 to 0.98. Fog conditions during many of the measurements were varying rapidly but the maximum spread of gray scale values was ± 20 percent of the average value. For the average values obtained from these measurements, the logarithm of the gray-scale readings was directly proportional to transmittance for transmittances from 0.1 to 0.94---visibility 1/16 to 2 miles. Later, additional calibrations will be made to determine if sensitivity is maintained.

AGA Visibility Meter.

Arrangements have been completed to obtain for testing a prototype visibility meter developed by AGA Aktiebolag of Sweden. This equipment will be delivered early in the next quarter and will have to be returned to the manufacturer within six months. In preparation for this installation a concrete foundation was poured near T-L2 transmissometer projector and an instrument shelter for protecting the equipment was moved into position. This visibility meter has the potential of obtaining data from directions other than horizontal. To obtain data relating the change of transmittance with height for use in the tests of the AGA visibility meter, the NBS slant visibility meter will be put back into operation. A new lamp was installed in the projector and this unit was put into operation. A power transformer had failed in the receiver and was replaced. A preliminary calibration of the receiver was made. Because of the short supply of lamps on hand, further work on the slant visibility meter will be resumed when more lamps are received.

Fog Variability Studies.

The tables and figures for the Summary Report on Low Visibility Conditions at the Arcata Airport which was discussed in the report for last quarter were completed.

Part of the text was drafted but the report has been delayed by a higher priority for the installing of the fog detectors. This report should be completed next quarter.

The restricted visibility conditions at the Arcata Airport for the months of October, November, and December, as recorded by the elapsed time meters, were as follows:

Instrument flight rules (IFR)	229 hours
Runway lights operated at step 5 intensity	35 "
Transmittance below 0.5 over a 500-foot baseline in daytime	52 "
Transmittance below 0.5 over a 500-foot baseline at night	129 "

Transmissometers.

Trouble was encountered with one of the transmissometers at Arcata. The analog record chart exhibited a ragged, unstable trace. The complete transmissometer system was examined and the cause was found to be a poorly attached filament in the projector lamp. Examination of the remaining lamps of the same batch showed that the poor filament clamping was peculiar to the single lamp and probably not to the entire lot.

The figures and a draft of the text for a report on the correction of zero shifts in the indicator at low pulse rates (discussed in the report for last quarter) was completed. This report was delayed in order to test some other types of capacitors for use in place of the "bathtub" capacitor currently used.

The NBS transmissometer instruction manual stated that incipient lamp failures can often be detected by an examination of the records for discontinuity occurring when the lamp is turned on after a background check. The applicability of this statement to lamps of recent manufacture has been questioned. Records showing recent examples of such discontinuities preceding lamp failure were sent to NBS at Gaithersburg for forwarding to other interested agencies.

III. AIRFIELD LIGHTING AND MARKING

Field Tests of Type L-842 Inset Runway Lights with Forced Drainage Modification.

The five type L-842 inset runway lights, three of which have been modified for forced drainage, are continuing on the long term test of operating continuously for three hours daily. The lights have now been on this test for six months. In December one lamp failed. This was the first lamp failure in nearly five months. All the lights were opened for inspection at the time of the lamp replacement. All lights were dry, and apparently neither the modified or the unmodified units had ever

accumulated appreciable moisture. Another inspection will be made before the end of the rainy season.

Centerline Lighting for SATS.

Four prototype centerline SATS lights have been machined from 17-4PH stainless steel. This is a tough, hardenable stainless steel that can be heat treated to a hardness of Rockwell C 36. These lights are designed to use a number of miniature type 715 lamps spaced approximately one-inch apart in 5/16-inch plastic tubing. Three separate tubes will be spaced one-inch apart as illustrated on figure 1. The type 715 lamp when operated at its design voltage, five volts, has approximately 60,000 hours life. If relamping of the light should become necessary, each tube may be replaced as a unit from the underside of the light. No photometric tests have been made to date.

Life Test of Q6.6A/PAR56/2 Approach-Light Lamps.

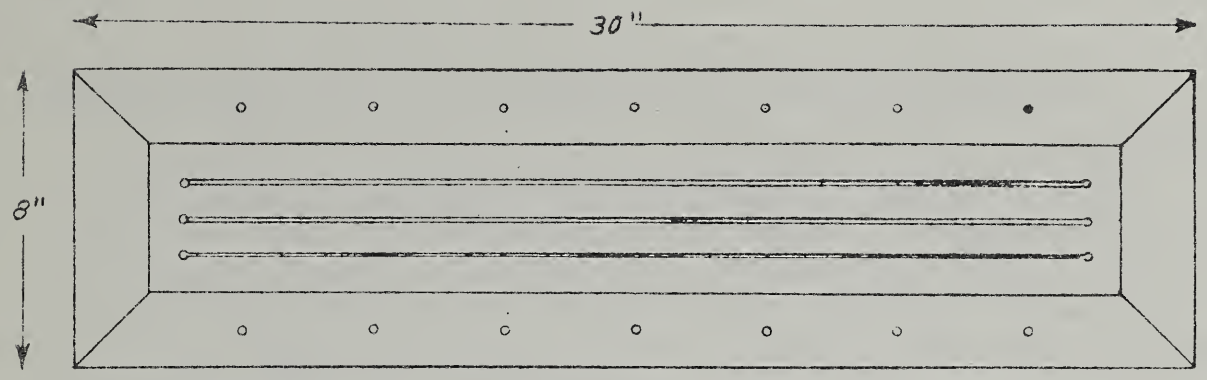
Seven 1000-hour type Q6.6A/PAR56/2 halogen-cycle approach-light lamps were life tested. Average time to burn out or to the time when the voltage dropped below 95% of the initial voltage was 1140 hours. NBS Test Report 212.11-22/67 Supplement was issued.

Effect of Lead Lengths on the Effective Intensity of Condenser Discharge Approach Lights.

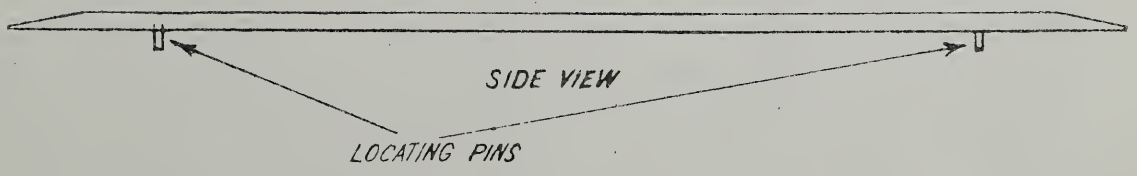
A type FT-34 (PAR-56) flashtube approach light was operated in a repetitively flashing mode from a type CD-100 Sylvania power supply. Insertion of one 100-foot length of cable with number 12 wires between the power supply and the light resulted in a 15% decrease in effective intensity; two 100-foot lengths resulted in a 22% decrease. A memorandum report was issued.

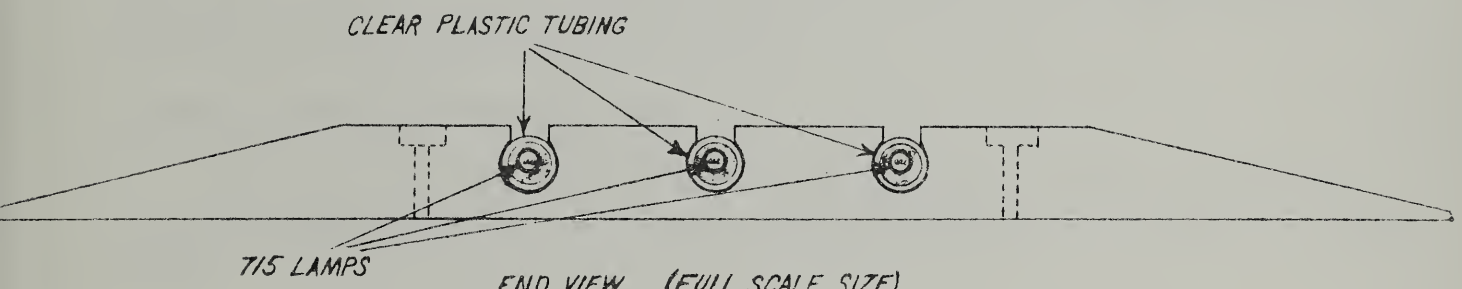
Condenser-Discharge Approach Light for SATS Field.

Photometric measurements were made of a condenser-discharge component of a Short Airfield for Tactical Support (SATS) light system to determine the effect of various lengths of cable between the source of power and the power supply. The cable lengths were simulated by resistors. One ohm, comparable to 500 feet of 2-wire, No. 10 cable, resulted in a decrease of 0.3% of the voltage on the capacitor. This decrease would result in a decrease in intensity of about 0.6%, which was not measurable. A memorandum report was issued..



TOP VIEW





END VIEW (FULL SCALE SIZE)

SATS CENTERLINE LIGHT

Factory-Aimed Type PAR-64 Halogen-Cycle VASI Lamps (Group 3).

Eight 2000-hour, "factory-aimed" type PAR-64 halogen-cycle VASI lamps were life-tested. The group was the third tested: Group 2 had shown a longer-than-design life and the factory was notified. The manufacturing process was changed to bring the filaments closer to design life. Group 3 showed a mean life (after seasoning for 48 hours) of 1830 hours and a median life of 1910 hours. Life was to the time of burn-out or to the time when the voltage dropped below 95% of the initial voltage.

Photometric Tests of 500-watt, 20-ampere PAR-56 Halogen-Cycle Approach- and Runway-Light Lamps with Clear Covers.

Tests were made of eight clear-cover lamps as possible replacement for the Q20A/PAR56/3 halogen-cycle lamp with stippled covers. Mean values are as follows: Power, 493 watts; peak intensity, 326 kilocandelas; intensity at 6° horizontal beam width, 204 kilocandelas, intensity at 5° vertical beam width, 174 kilocandelas. Note: The latter two values are specified in MS 24488 (USAF) to be not less than 200 kilocandelas. The lamps will be tested in a type BB (1/2-inch projection) and a type B (1-inch projection) semi-flush light and the lamps will be life tested.

Improved Heliport Perimeter Light.

NBS Test Report 212.11-88/66 was issued giving the results of photometric measurements of several fixture-lamp combinations for use as heliport perimeter lights.

IV. CARRIER LIGHTING AIDS

Weight Display Unit.

Prior to his being launched, the carrier pilot is informed of the aircraft weight used in determining the thrust setting of the catapult. A method of displaying this weight setting to the pilot has been developed. It consists of a hand-held, self-contained, battery-operated unit that will display to the pilot five four-inch high internally-illuminated digits. The first three digits displayed can be readily changed. (The last two digits are zeros). Thus the catapult setting in hundreds of pounds can be displayed.

The brightness of this unit is low, as the unit is meant for night use only. If a presentation system of this type is desired for daylight use, it would be necessary to power it from an external power source because of the current requirement of the higher intensity required.

Internal, front, and back views of this unit are shown in figure 2.

The unit will be sent to NAS Lakehurst for service evaluation in the near future.

V. MISCELLANEOUS TECHNICAL AND CONSULTIVE SERVICES

The following proposals, draft reports and specifications have been reviewed. Comments have been forwarded by letter, marked copy of the document and/or conferences with cognizant DOD and FAA personnel.

MIL-C-5136C Cable, Power, Polychloroprene Sheathed, Buna Compound Insulated

MIL-L-7082D Light, Runway Marker, Elevated, Type M-1

Draft Revision of Advisory Circular "Aeronautical Beacons and True Lights"

Draft Revision of Advisory Circular "Obstruction Lighting"

FAA Specification 1100 Photometric Procedures for Condenser-Discharge Lamps

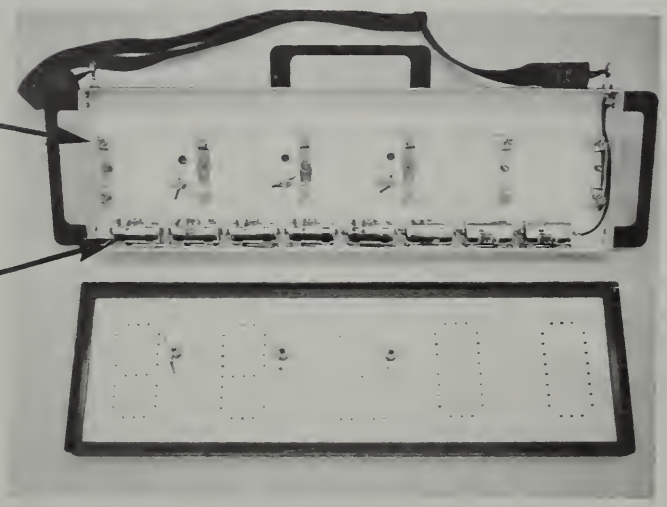
FAA Specification L 852 Light Assembly, Wide Angle, Airport Taxiway Centerline

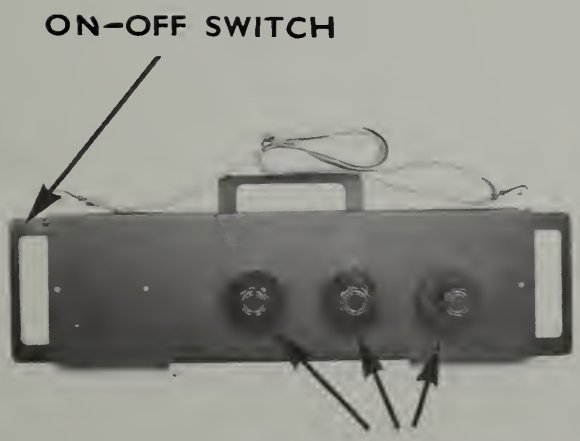
VI. MISCELLANEOUS

Intensity of a Gasoline Lantern.

The use of gasoline lanterns to mark the landing area at McMurdo Sound during the winter months has been proposed because of the difficulty of setting up a portable electrical lighting system. At the request of the Naval Facilities Engineering Command measurements were made of the intensity of a Coleman single-mantle lantern. Intensities in the range 100 to 200 candelas were observed. The intensity was, as would be expected, somewhat dependent upon the direction of view and on the pressure of the fuel tank.

FRONT VIEW





BACK VIEW

WEIGHT DISPLAY UNIT

FIGURE 2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